



Short Communication

Copepod (Crustacea) infection on Oil sardine, *Sardinella longiceps* Valenciennes, 1847 (Actinopterygii; Clupeidae) - First report

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Among the Clupeidae, the oil sardine, *Sardinella longiceps*, Valenciennes, 1847 dominates the catches of commercial boats in India. Despite two reports on isopod infection, no further information on parasitic crustacean infection on this fish species was available to date. Between June 2014 and April 2018, we examined 1513 specimens of *S. longiceps*, obtained from Cochin and Malabar Coast (Kerala, India) where we report for the first time the exclusive infection of this fish by the Lernaepodid copepod, *Clavellisa ilishae*. This parasitic copepod was observed on the gill arches of the host collected from Malabar Coast; the specimens were all sexually mature females bearing egg sacs. Curiously, this copepod parasite was recovered only in a period of three months from October to December in the year 2017 even though the observation was continued for a total of 4 years from 2014-2018. This observation must be addressed further in terms of ecological impacts.

[**Keywords:** *Clavellisa ilishae*, First report, India, Parasitic copepod, Parasitic parameters, *Sardinella longiceps*]

Introduction

Clupeids, representing the significant proportion of the marine fish biomass are highly vulnerable for infection by parasitic crustaceans and in several cases it leads to the economic losses in fisheries¹⁻⁸. Among them all *Sardinella* sp. in general and *Sardinella longiceps* (oil sardine) in particular dominate the commercial catches landed in India^{9,10}. Surveying through the literature, only two reports are available on the parasitic crustacean infection on *S. longiceps* and in both cases it was by the isopods^{11,12}. Although a few reports of parasitic copepod infection in some *Sardinella* species (*Sardinella fimbriata*, *S. aurita*, *S. albella*, *S. gibbosa*)¹³⁻¹⁹ are available, such reports in *S. longiceps* are nil to date. In this context, the present paper is relevant as it appears the first

report on the parasitic copepod infection on *S. longiceps*.

Material and Methods

The present study was conducted during June 2014 to May 2018. Marine fishes were collected afresh directly from the local fishing boat harbored at Ayyikkara (11°51' N, 75°22' E), Azhikkal (11°56'00" N, 75°18'00" E), Chombala (11°39' N, 75°33' E) of Malabar and Toppumpadi harbour in Cochin (10°18'00" N, 76°17' E). Immediately after collection, the fish body parts including body surface, buccal cavity, branchial cavity, lateral line region, cornea, inner wall of the operculum, fin rays, caudal lobes and gill filaments were closely examined for infection by the parasitic crustacean with the help of magnifying lens. The recovered *Clavellisa* sp. were immediately removed from the gill arches and preserved in 70 % ethanol²⁰ for further observation to identify the parasite at species level. The parasite along with the infected host fish was brought to the laboratory in order to have a close examination of the site of infection for further study on host fish and parasite. The parasite and its site of infection on the host fish were observed under dissection microscope and stereo microscope (Leica- S6D; 4X) as well.

The taxonomic identification of the recovered parasitic copepod was performed according to Pillai¹⁷. Photography of the host fish and the parasite was done using both Olympus (μTOUGH- 3000) and camera attached with stereo microscope Leica- S6D. Parasitological parameters [Prevalence (P %) = the number of infected hosts / the number of examined hosts x 100; Mean Intensity (I) = the number of parasites recovered/ number of fishes infected] were calculated according to Bush *et al*²¹. Host nomenclature and fish taxonomy were performed based on Fish Base (Froese and Pauly²²). Voucher specimens of *C. ilishae* (accession no. CI- 01F, CI-02F, CI-03F) were deposited in the Parasitic Crustacean Museum, Crustacean Biology Research Laboratory, Sree Narayana College, Kannur, Kerala, India.

Results and Discussion

A total of 1513 specimens of *Sardinella longiceps* were observed during the study period (Table 1).

Among them, 30 members showed infection with a parasitic copepod *Clavellisa ilishae*, Pillai, 1962 which appears to be the first instance of a parasitic copepod infection on this *Sardinella* species; the average annual prevalence and intensity being 1.98 and 1.60, respectively. All recovered parasites were sexually matured females as evidenced by the presence of egg sacs containing eggs found attached on the gill arches of its host fish, *S. longiceps* (Fig. 1). Though scarce, this fish species (*S. longiceps*) from southern coast of India have been shown to have infection by two species of parasitic isopods (*Anilocra dimidiata* and *Nerocila phaiopleura*)^{11,23}. But, during

the present study, no isopod species was recovered from the *S. longiceps* distributed along the Cochin and Malabar Coast. This indicates the marked difference in the geographical distribution of parasitic crustaceans which in turn apparently under the influence of ecological factors.

Few reports are available on the infection by parasitic copepod on other *Sardinella* species; the fringe scale sardinella, *S. fimbriata* shown to have the infection with lernanthropid copepod, *Mitrapus oblongus* and bomolochid copepod, *Pumiliopes squamosus*^{13,14,18} from Kerala Coast. *Pumiliopes sardinellae* and *Peroderma cylindricum* were recovered from perforated-scale sardine, *S. albella* distributed along the Coast of India¹⁷. In a recent report, *S. albella* from South West Coast of India was also found infected with an isopod, *Nerocila Phaiopleura*²⁴ and those host fishes from Thailand has shown to have the infection by another *Nerocila* species (*N. depressa*)²⁵. The goldstripe sardinella, *S. gibbosa* showed infection with parasitic isopods *Aega* sp. from the Kenyan coast²⁶, *Aega psora* from the coastal waters of Egypt²⁷, *Nerocila triangulata* and *Ryukyua globosa* from the south east coast of India²⁰ *S. aurita* from the Turkish waters was also found infected with *M. oblongus*²⁸. These informations indicating that aforesaid *Sardinella* species were more prone to parasitic infection while comparing to *S. longiceps*. Why some particular fish species of same genus have higher parasite species richness? This question needs to be addressed properly for a thorough understanding on the host response against parasites.

The lernaepodid copepod *Clavellisa ilishae*, a highly specialized gill parasite, was first reported in the clupeid fishes *Tenualosa ilisha* and *Ilisha filigera* from the Bay of Bengal¹⁸. The clupeids *Sardinella aurita* from the Mediterranean Sea, *S. brasiliensis* from Brazil and *Sardinops sagax* from Africa also form the host for this parasitic copepod with a prevalence of 6.60 %, 10.00 % & 4.00 %, respectively^{3,29,30}. Recently, the studies from our laboratory has also shown the presence of this parasite infesting the new host *S. fimbriata* distributed along the Malabar coast of India, with the prevalence and intensity respectively 7.13 and 4.03. Present study along with the previous reports signifies the clupeid host specificity of this parasitic copepod agreeing the view of El-rashidy and Boxshall³, who suggested that *C. ilishae* have been found associated with clupeiform fishes, particularly from Indian waters.

Table 1 — Details of monthly collection of *Sardinella longiceps* and their copepod (*Clavellisa ilishae*) infection status during the period from June 2014 to April 2018 (NFO- Number of fishes observed, NFI- Number of fishes infected)

Month	June 2014- May 2015		June 2015- May 2016		June 2016- May 2017		June 2017- May 2018	
	NFO	NFI	NFO	NFI	NFO	NFI	NFO	NFI
June	13	-	12	-	51	-	81	-
July	27	-	18	-	18	-	70	-
August	14	-	14	-	13	-	90	-
September	12	-	38	-	12	-	73	-
October	13	-	15	-	57	-	62	18
November	31	-	21	-	36	-	89	11
December	37	-	26	-	24	-	24	1
January	26	-	32	-	29	-	12	-
February	18	-	21	-	22	-	59	-
March	13	-	30	-	28	-	73	-
April	17	-	17	-	15	-	37	-
May	13	-	18	-	22	-	20	-
Total	234	0	262	0	327	0	690	30

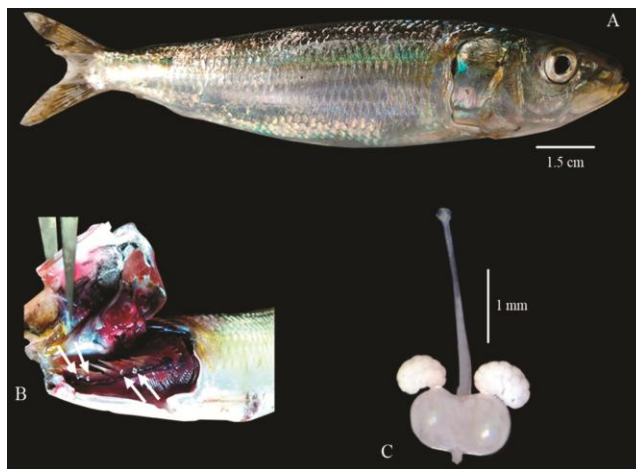


Fig. 1 — *Sardinella longiceps* infected with parasitic copepod *Clavellisa ilishae*. A- Host fish, *S. longiceps*, B- Site of infection of *C. ilishae*, and C- *C. ilishae*

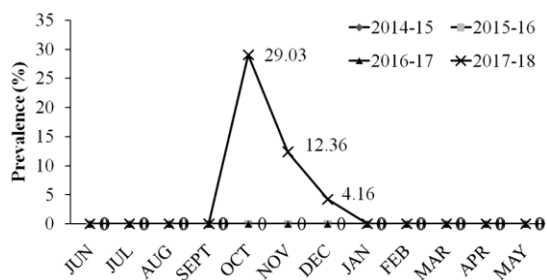


Fig. 2 — Monthly Variation in prevalence of *Clavellisa ilishae* on *Sardinella longiceps* during the period from June 2014 - May 2018

Recent studies from our laboratory reports the season dependent variation in the rate of infection of parasitic copepod, *Peniculus fistula fistula* on clupeid host, *Anadontostoma chacunda*; winter season extending from November to January exhibits highest prevalence (13.02 ± 2.54) followed by summer season (February- May), but significantly very less value (3.51 ± 1.19). During the post-monsoon (September - October), recorded prevalence is < 1.2 and no infection was recorded during monsoon suggest the possible impact of ecological parameters¹⁶. Though the present host fish, *S. longiceps* were closely examined for a period of four years (June 2014 to May 2018), it didn't show any species of parasitic crustacean infection other than *C. ilishae*. Significantly, the presence of this lernaeopodid copepod (*C. ilishae*) was noticed only during the months October, November and December, 2017 with a prevalence of 29.03 %, 12.36 % and 4.16 %, respectively (Table 1; Fig. 2). The question of this inconsistent pattern in the infection of this lernaeopodid copepod on the host fish, *S. longiceps* needs to be addressed further in terms of the ecological impacts.

Conclusion

The present study is relevant not only in the context of the first report on the parasitic copepod infection on Oil sardine, *S. longiceps*, but also the identification of new host for this parasitic copepod, *C. ilishae*. This information encourages pursuing further study on the host-parasite interaction and their evolutionary significance. The inconsistent pattern in the infection of this lernaeopodid copepod on the host fish, *S. longiceps* also needs to be addressed in ecological terms.

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Competing Interests

The authors declare that they have no conflict of interests and all authors have given consent for publication.

Author Contributions

RK, AS, NMV and DOK are the main workers on the topic and RK prepared the draft of the manuscript. SK drew out the concept, supervised the work and corrected the manuscript. All authors read and approved the final manuscript.

Availability of Data and Materials

Voucher specimens were deposited in the collections of PCM-CBRL, Sree Narayana College, Kannur, Kerala- 670007, India.

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